1 Error propagation

Quick summary notes

- Used amended χ^2 equation

$$\chi^2 = \sum_{i=1}^{N} \frac{(y_i - f(p_i : \vec{\theta}))^2}{\sigma_i^2 + \sigma_0^2}, \tag{1.1}$$

  y_i is the data value at i^{th} pixel, $f(p_i; \vec{\theta})$ is the value given back by a Gaussian function at i^{th} pixel location, σ_i is the Poisson error and σ_0 is quadrature scale factor introduced to increase the error. $\vec{\theta}$ is the parameters of the Gaussian function.

- Gaussian equation used is

$$f(p; a, b, \sigma, \mu) = \frac{a}{\sqrt{2\pi}\sigma} e^{\frac{-(p-\mu)^2}{2\sigma^2}} + b, \tag{1.2}$$

  where a represents amplitude, p indicates the pixel location, μ is the mean for each peaks, σ is the width of the Gaussian curve and b is the background.

- $\vec{\theta}$ consist of a, p, μ and σ.

- Selected σ_0 of 6E4 and applied it to all of the spectral lines to get a decent error. This gave decent errors on peaklocation.

- For high intensity peaks chosen $\sigma_0 = 6\text{E}4$ values would be too low, for low intensity peaks $\sigma_0 = 6\text{E}4$ would be too high but on average it gave decent errors on the lamp data.

- Some example plots

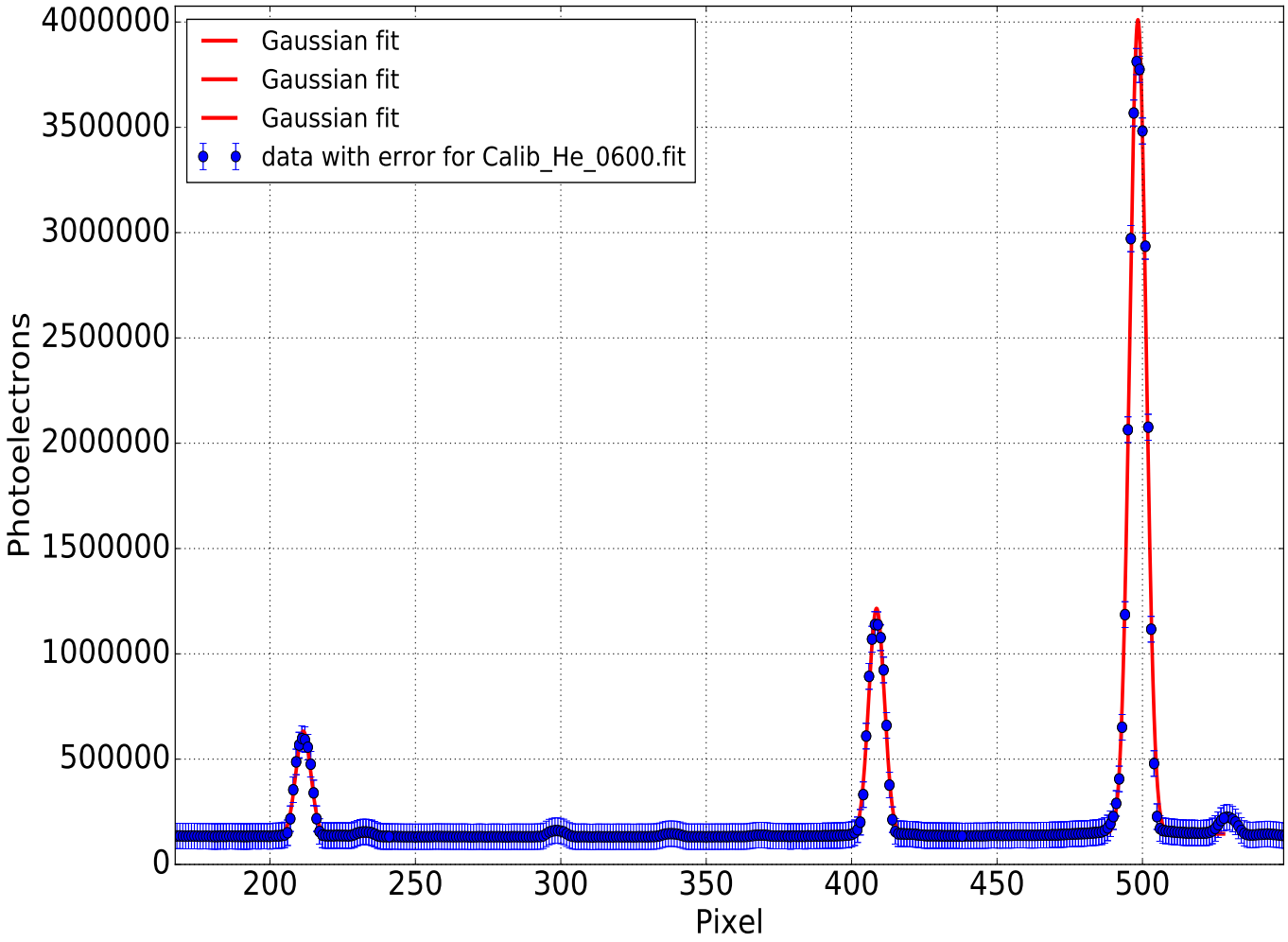

Figure 1: The error bar seems of reasonable value. For the first line the error on peak was 0.2053, second had error on peak of 0.0965 and third had error on peak of 0.0277. Their χ^2 was 2.96,9.92 and 82.55 respectively. Ideally $\chi^2 \approx \mathrm{N_{D.O.F}}$. $\mathrm{N_{D.O.F}} = 56$ for each fit around the spectral line. From the various χ^2 value its obvious for line 1 and line 2 σ_0 is an overestimate, while for line 3, σ_0 is around the selected value.

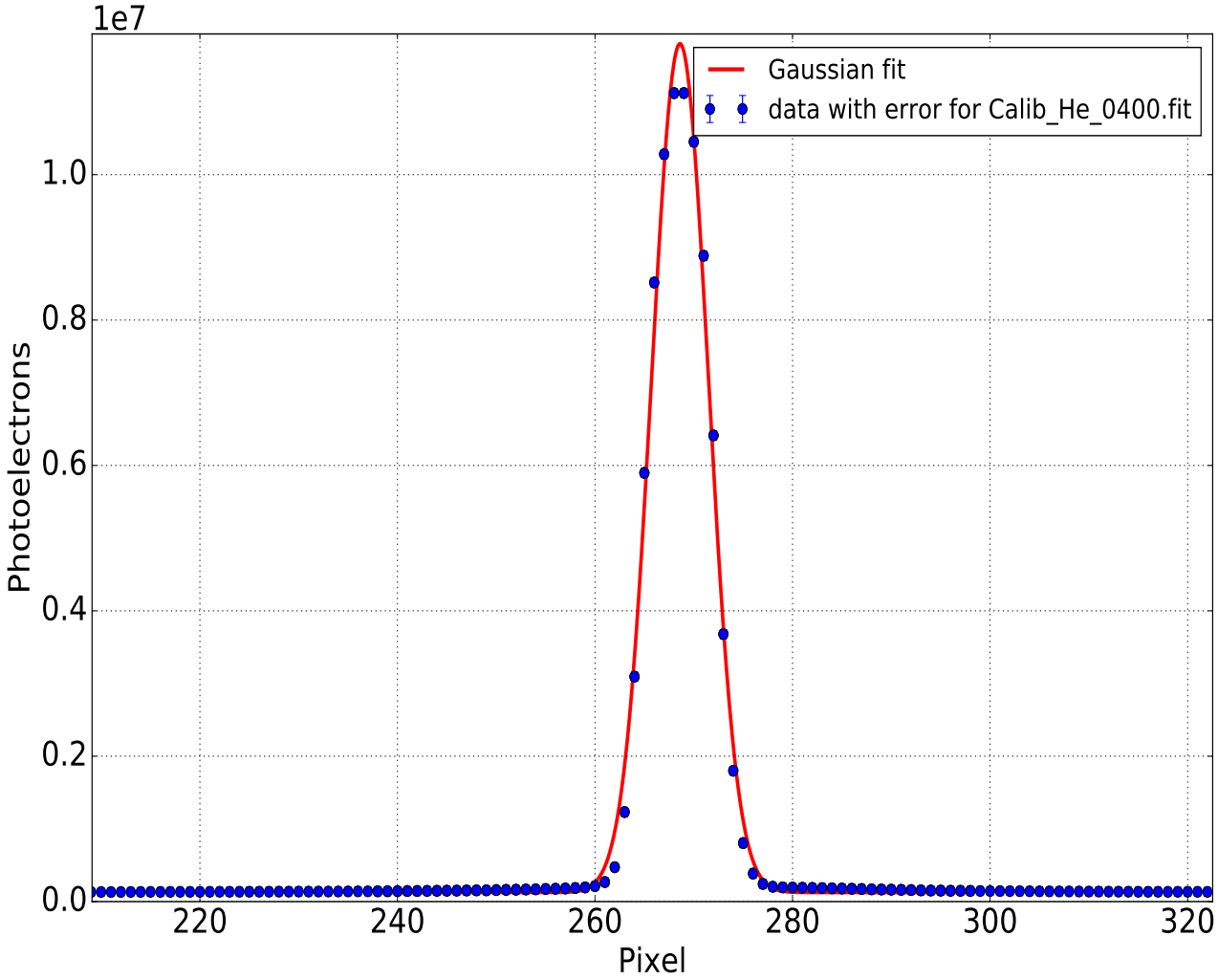

Figure 2: The error bar seems too small on this curve, however they are still present. The error on peak location for this specific spectral line was 0.0093 and ithad a χ^2 value of 749.34. $N_{DOF} = 56$, therefore the σ_0 is still an underestimate.

- Below is a table for the obtained χ^2 value and their corresponding error for each spectral line. For each line $\sigma_0 = 6E4$.

- Data for cadmium

		χ^2			Error on peak		
Micrometer (mm)	range	line 1	line 2	line 3	Peak 1	Peak 2	Peak 3
2.50	61	437.21			0.0216		
3.00	61	63.66			0.0164		
3.50	61	34.95			0.0171		
5.00	61	1887.26			0.0091		
5.50	61	1028.07	1469.41		0.009	0.0056	
6.00	61	423.49	1405.93	461.57	0.0107	0.0059	0.0064
6.50	61	312.66	422.06		0.0105	0.0067	

- Error on wavelength

		Error on wavelength		
Micrometer (mm)	range	Peak 1	Peak 2	Peak 3
2.50	61	0.105		
3.00	61	0.104		
3.50	61	0.103		
5.00	61	0.098		
5.50	61	0.097	0.096	
6.00	61	0.096	0.096	0.096
6.50	61	0.095	0.095	

- The rest of the data follows similar pattern (All data on text file "Errors.txt").

- Plots of data and fit with error bars:

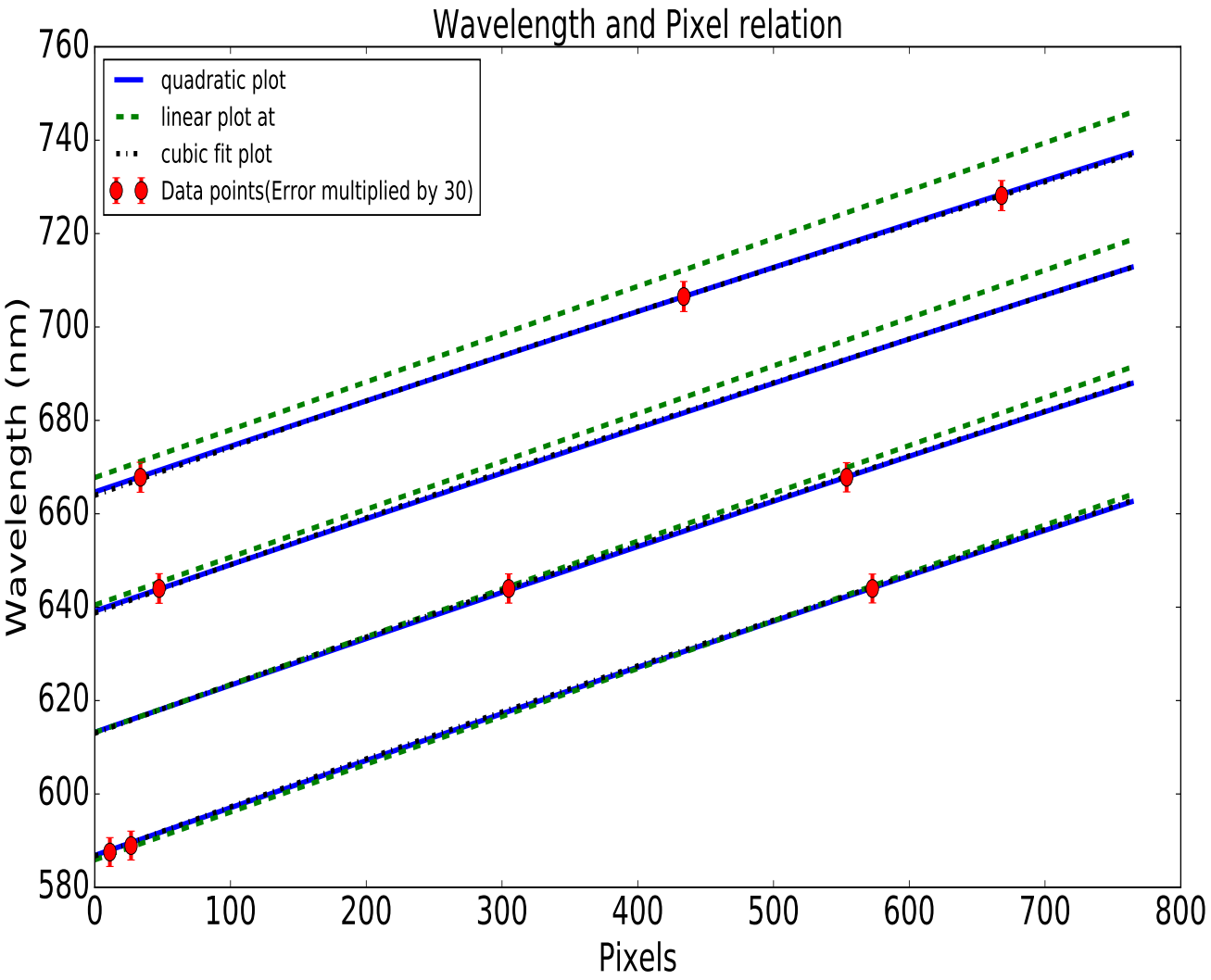

Figure 3: This shows the plot for the linear, quadratic and the cubic fit along with all data for micrometer setting of 2.0 mm, 2.5mm, 3.0mm and 3.5mm.

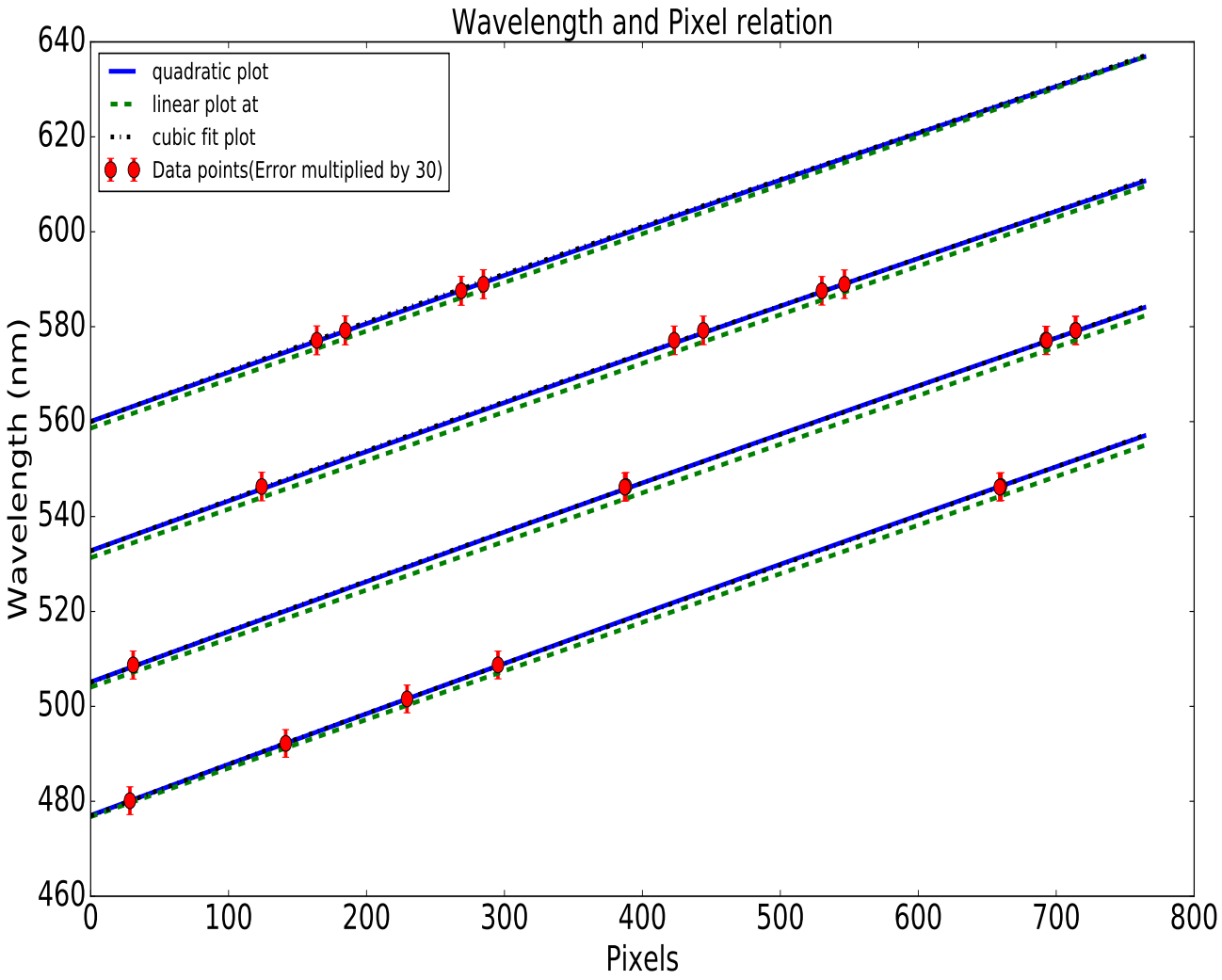

Figure 4: This shows the plot for the linear, quadratic and the cubic fit along with all data for micrometer setting of 4.0 mm, 4.5mm, 5.0mm and 5.5mm.

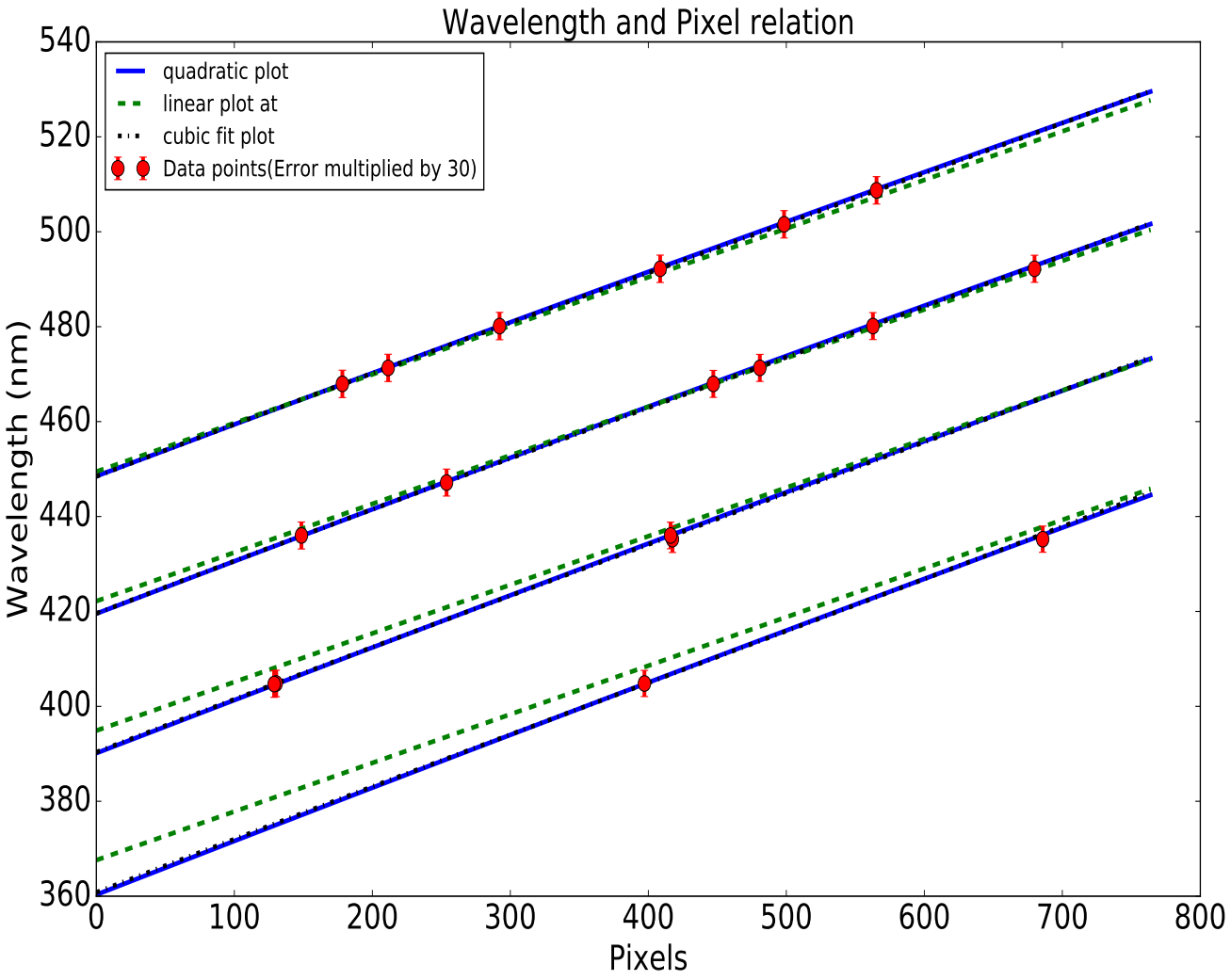

Figure 5: This shows the plot for the linear, quadratic and the cubic fit along with all data for micrometer setting of 6.0 mm, 6.5mm, 7.0mm and 7.5mm.

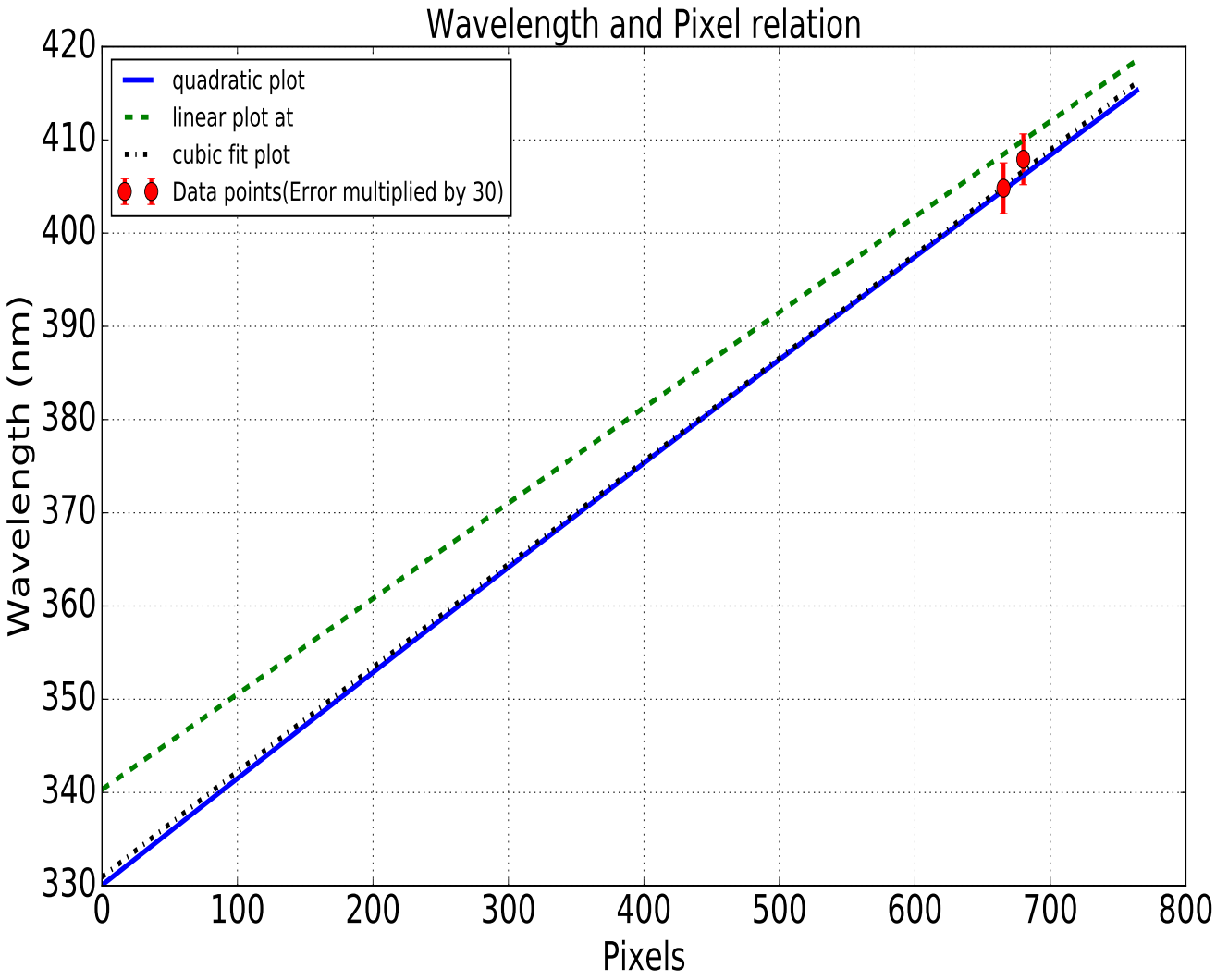

Figure 6: This shows the plot for the linear, quadratic and the cubic fit along with all data for micrometer setting of 8.0mm.

Table 1: This shows the χ^2 values for different fits.

Parameters	Linear fit	Quadratic fit	cubic fit
N_{DOF}	46	43	39
χ^2	26832.36	973.96	710.67
χ^2/N_{DOF}	609.826	22.650	18.222